Parasite Community Composition: Insights on the Ecology and Migration of Juvenile Salmon

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Numerous studies have used parasites as biological tags for understanding the origins and migrations of marine fishes. Reviews by Lester (1990), Moser (1991), and MacKenzie and Abaunza (1998) describe many of these studies and summarize the guidelines for using parasites as biological tags. In principal, fish become infected with a parasite only if they come within an endemic area of the parasite. If infected fish are sampled outside of the endemic area we can conclude that they migrated through that habitat (MacKenzie and Abaunza 1998). By following these guidelines researchers have successfully used parasites to determine differences in recruitment and migration of anadromous and marine fishes.

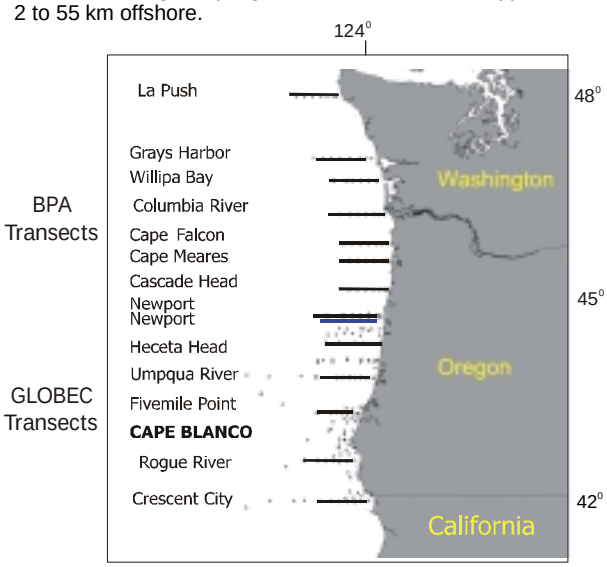
Studies have used single parasite species to identify stocks of sockeye salmon (*Oncorhynchus nerka*) (Margolis 1963; reviewed in Konovalov 1995) and chinook salmon (*O. tshawytscha*) (Urawa et al. 1998) in the North Pacific Ocean and the Bering Sea. Parasite communities have also been used to determine migratory patterns of sockeye salmon in the Strait of Georgia, British Columbia (Groot et al. 1988). We are exploring both approaches for juvenile chinook salmon and coho salmon (*O. kisutch*) populations in the Northern California Current (NCC).

Our parasite analyses are components of two ecosystem projects in the NCC designed to examine influences on early-ocean growth and survival of juvenile chinook salmon and coho salmon. A project funded by the Bonneville Power Administration focuses on the potential effect of the Columbia River plume habitat on the ocean ecology of juvenile salmonids. A second project funded by the U.S. Global Oceans Ecosystems Dynamics (U.S. GLOBEC) focuses on how wind-driven processes and the physical features near Cape Blanco in Oregon might affect oceanographic conditions, local productivity, zooplankton populations, juvenile salmonid populations, and their interactions.

Although it is a critical period for growth and survival, information on the early marine ecology of juvenile salmon off of Oregon and Washington is limited (Pearcy 1992). We study parasite communities to help characterize trophic interactions, habitat, migration, and salmon population origins during early marine residence. As parasitologists, our interests in juvenile salmon origins are two-fold. Salmon pathogens acquired in freshwater, such as *Nanophyetus salmincola*, *Renibacterium salmoninarum*, and *Ceratomyxa shasta*, could continue to affect juvenile salmon upon and after entering the ocean. Differences in pathogen prevalences from different freshwater systems could result in differential growth or survival. However without known stock origins this cannot be confirmed. Also, we are attempting to use non-pathogenic parasites to help delineate stocks or elucidate movement and migration of juvenile salmonids within and through Oregon and Washington coastal waters.

Juvenile salmon were caught along transects between Crescent City, California and La Push, Washington with a 30m – 20m rope trawl fished near the surface. Cruises were conducted between May and September of 1998–2000 (Fig. 1). Lengths and initial identifications were done at sea and fish were immediately frozen. Muscle,

Fig. 1. Map of the two study areas in the Northern California Current showing sampling transects that run from approximately 2 to 55 km offshore.



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stomachs, intestines, and body cavities were examined for parasites. Multivariate community analyses were performed with the PRIMER computer software package (PRIMER-E Ltd, Plymouth).

Our analyses on habitat and migration studies focused on parasites acquired through trophic interactions. We identified 17 different parasites from juvenile chinook salmon and coho salmon: 4 nematodes; 7 trematodes; 3 acanthocephalans; and 3 cestodes. Prevalences and intensities varied between the two salmonids, but these parasites were found in both species. We chose the most prevalent parasites for community analyses.

Spatial comparisons within the NCC suggested geographic differences in the distribution of two common trematodes: *Brachyphallus* sp. and another hemiurid trematode (Fig. 2). *Brachyphallus* sp. was most prevalent in salmon caught off of Northern Washington and not found in juvenile salmon south of Newport, Oregon. The other hemiurid trematode was most prevalent south of Newport. The lifespan of these parasites within salmon is unknown but based on other marine hemiurids is a minimum of several months (Rhode 1984). These trematodes may have potential as migration markers for juvenile salmon off of Oregon and Washington.

Fig. 2. Prevalences of two trematodes isolated from the stomachs of juvenile salmon sampled off of Washington and Oregon. Data were combined from Chinook salmon and coho salmon sampled from summer cruises conducted in 1998–2000. Transects span from northern Washington (La Push) to northern California (Crescent City).

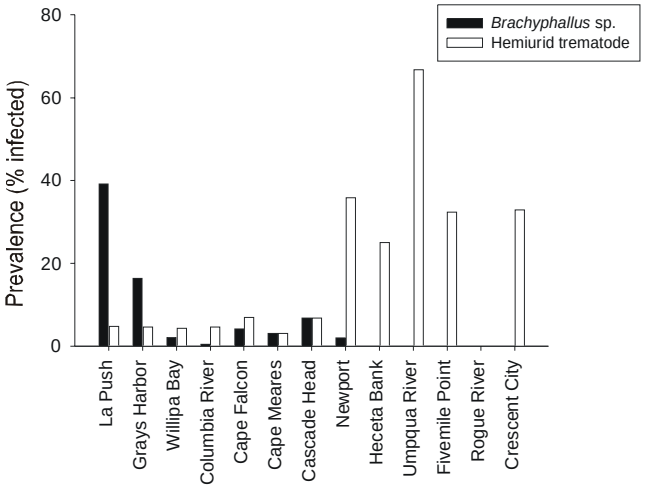
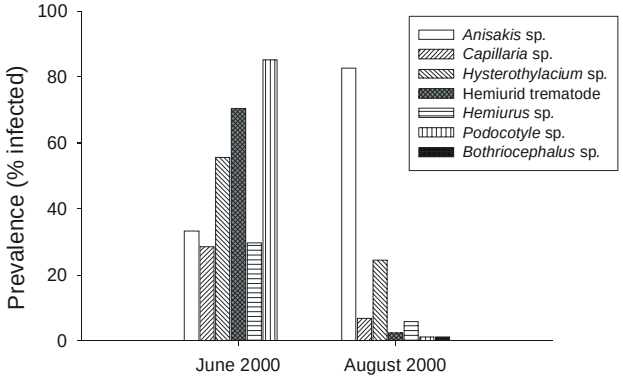


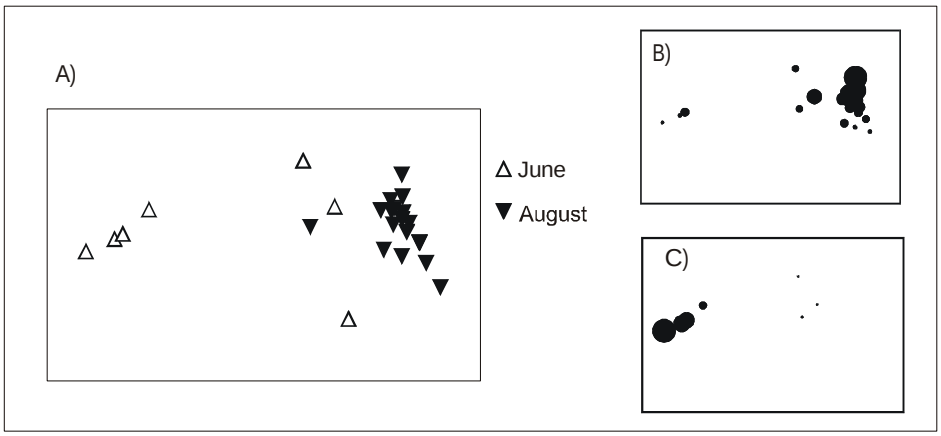
Fig. 3. Prevalences of nematodes and trematodes of yearling Chinook salmon caught in the GLOBEC study area in 2000.



Examining the temporal patterns of parasitic infections within the same region provided insights into juvenile salmon habitat use and migration off of southern Oregon and northern California. During our 2000 GLOBEC studies we found that the prevalences of most parasite species were different in chinook salmon caught in August compared to June (Fig. 3). For example, the prevalence of *Anisakis* sp. was 83% in August and 33% in June, although intensities did not differ. Most of the other parasite species declined in prevalence. The known longevity of these parasites suggested that the June and August fish were not from the same populations. Multivariate analyses of these parasite communities also suggested different fish populations based largely on the increase in the prevalence of anisakid nematodes and declines in prevalence of the trematode *Podocotyle* sp. (Fig. 4). Our interpretations were supported by genetic mixed stock analysis, which indicated that during June, most of the chinook salmon sampled south of Newport, Oregon originated from rivers along the central Oregon coast. In August, chinook salmon sampled south of Cape Blanco, Oregon were largely from southern Oregon and northern California coastal streams, while north of Cape Blanco most were from the California Central Valley (Brodeur et al. 2004).

In conclusion, we found different geographical distributions in the Northern California Current of two trematode species in juvenile salmon. We used parasite communities to support temporal shifts in salmon habitat use. Further research and analyses are needed to determine how parasites in juvenile salmon will compliment other tagging efforts. Possibilities include the addition of other parasites to the analyses, genetic analyses of key parasite populations, increased temporal sampling, and further statistical testing. We are also currently analyzing our results with microsatellite information on a subset of juvenile chinook salmon from the GLOBEC study area. Due to the different time scales addressed by genetics, parasites, and conventional tagging, the conclusions drawn from each method may differ, but together they provide a more robust study of fish stocks (Lester 1990).

Fig. 4. A) Multi-dimensional scaling (MDS) of Bray-Curtis similarities between parasite communities of yearling chinook salmon sampled in the GLOBEC study area in 2000. Data were averaged by station resulting in mean abundance per station. Bubble plots on MDS show mean parasite abundance per station, B) *Anisakis* sp. C) *Podocotyle* sp.



REFERENCES

Brodeur, R., J.P. Fisher, D.J. Teel, R.L. Emmett, E. Casillas, and T.W. Miller. 2004. Distribution, growth, condition, origin, and environmental and species associations in the Northern California Current. Fish Bull. 102: 25-46.

Groot, C., R.E. Bailey, L. Margolis, and K. Cooke. 1988. Migratory patterns of sockeye salmon (*Oncorhynchus nerka*) smolts in the Strait of Georgia, British Columbia, as determined by analysis of parasite assemblages. Can. J. Zool. 67: 1670–1678.

Konovalov, S.M. 1995. Parasites as indicators of biological processes, with special reference to sockeye salmon (*Oncorhynchus nerka*). Can. J. Fish. Aquat. Sci. 52 (Suppl. 1): 202–212.

Lester, R.J.G. 1990. Reappraisal of the use of parasites for fish stock identification. Aust. J. Mar. Freshwater Res. 41: 855–864.

MacKenzie, K., and P. Abaunza. 1998. Parasites as biological tags for stocks discrimination of marine fish: a guide to procedures and methods. Fish. Res. 38: 45–56.

Margolis, L. 1963. Parasites as indicators of the geographical origin of sockeye salmon, *Oncorhynchus nerka* (Walbaum), occurring in the North Pacific Ocean and adjacent seas. Int. North Pac. Fish. Comm. Bull. No. 11: 101–156.

Moser, M. 1991. Parasites as Biological Tags. Parasitol. Today 7(7): 182–185.

Pearcy W.G. 1992. Ocean Ecology of North Pacific Salmonids. University of Washington Press, Seattle and London.

Rhode, K. 1984. Ecology of marine parasites. Helogol. Meeresunters. 37: 5–33.

Urawa, S., K. Nagasawa, L. Margolis, and A. Moles. 1998. Stock identification of Chinook salmon (*Oncorhynchus tshawytscha*) in the North Pacific Ocean and Bering Sea by parasite tags. N. Pac. Anadr. Fish Comm. Bull. 1: 199–204.